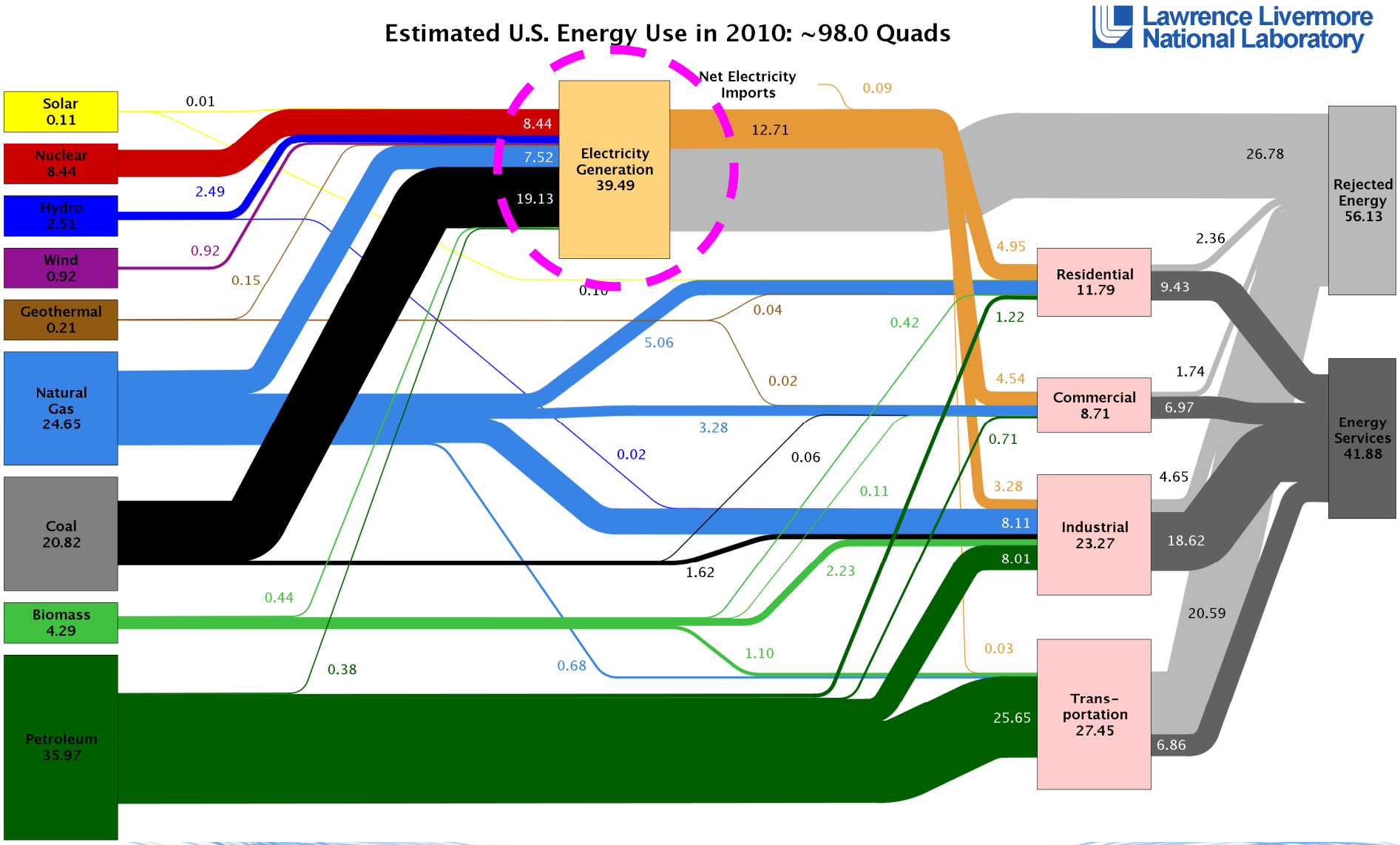
Zero Carbon Power

ARPA-E Objectives and Project Examples

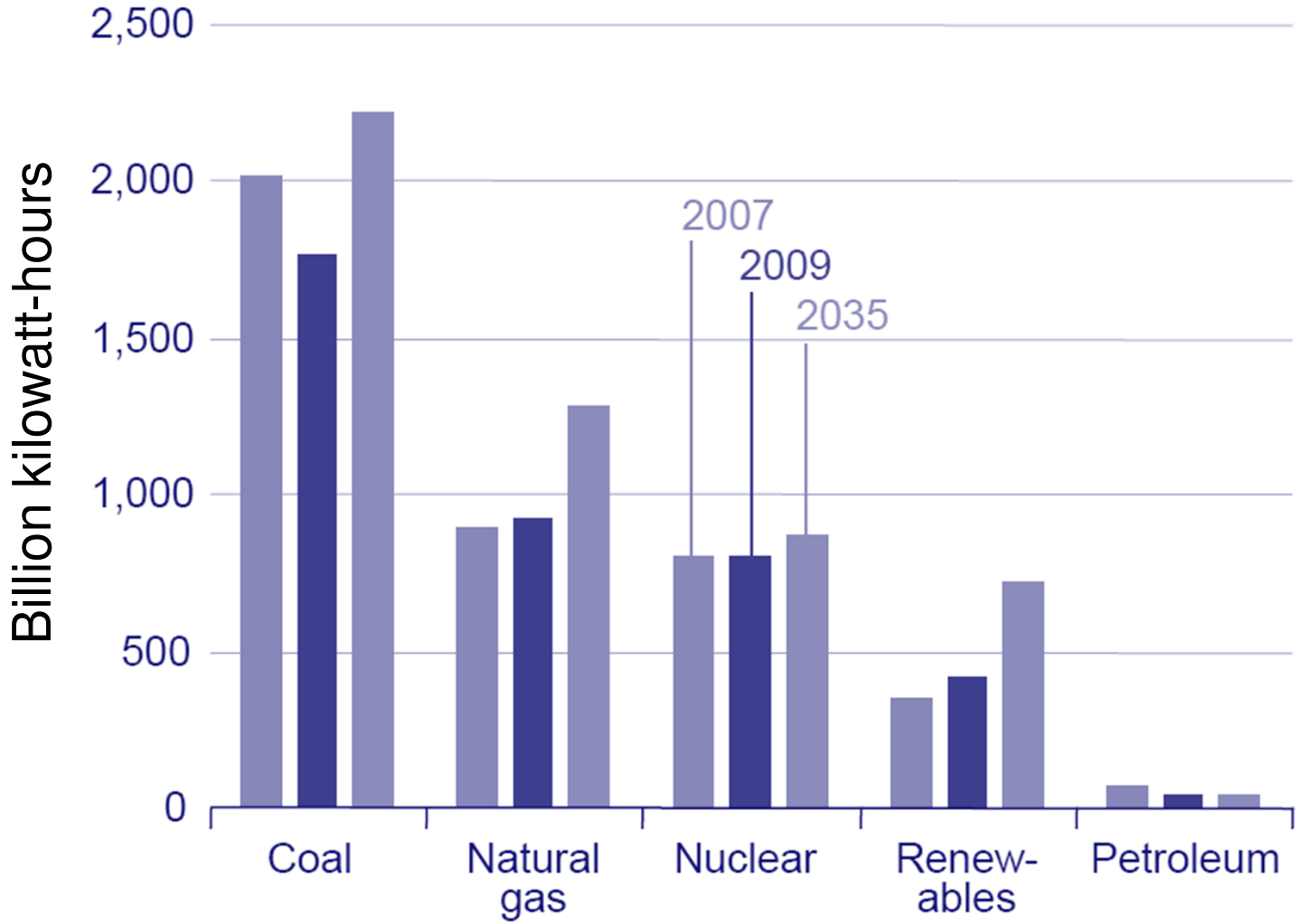
Mark Hartney, Program Director
Karma Sawyer, Assistant Program Director

Roughly half of U.S. electricity is coal-based



Source: LLNL Energy Flow Charts (2010)

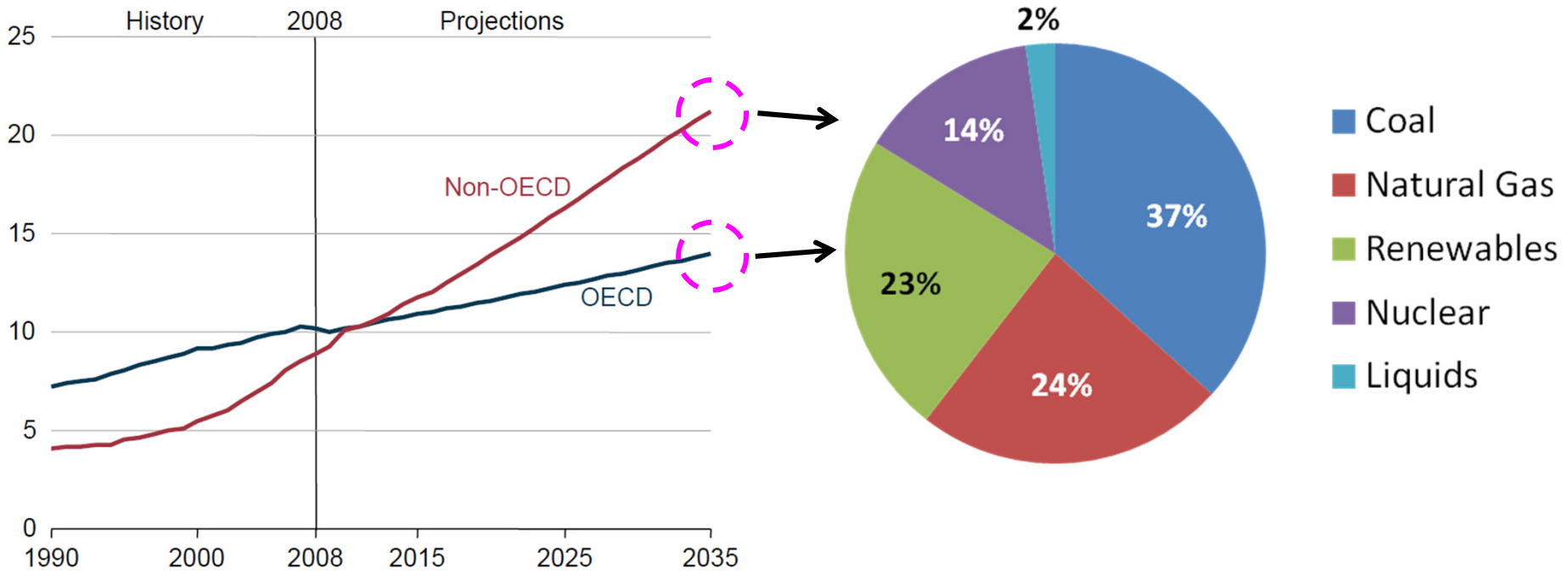
U.S. electricity generation projections



Source: EIA Annual Energy Outlook (2011)

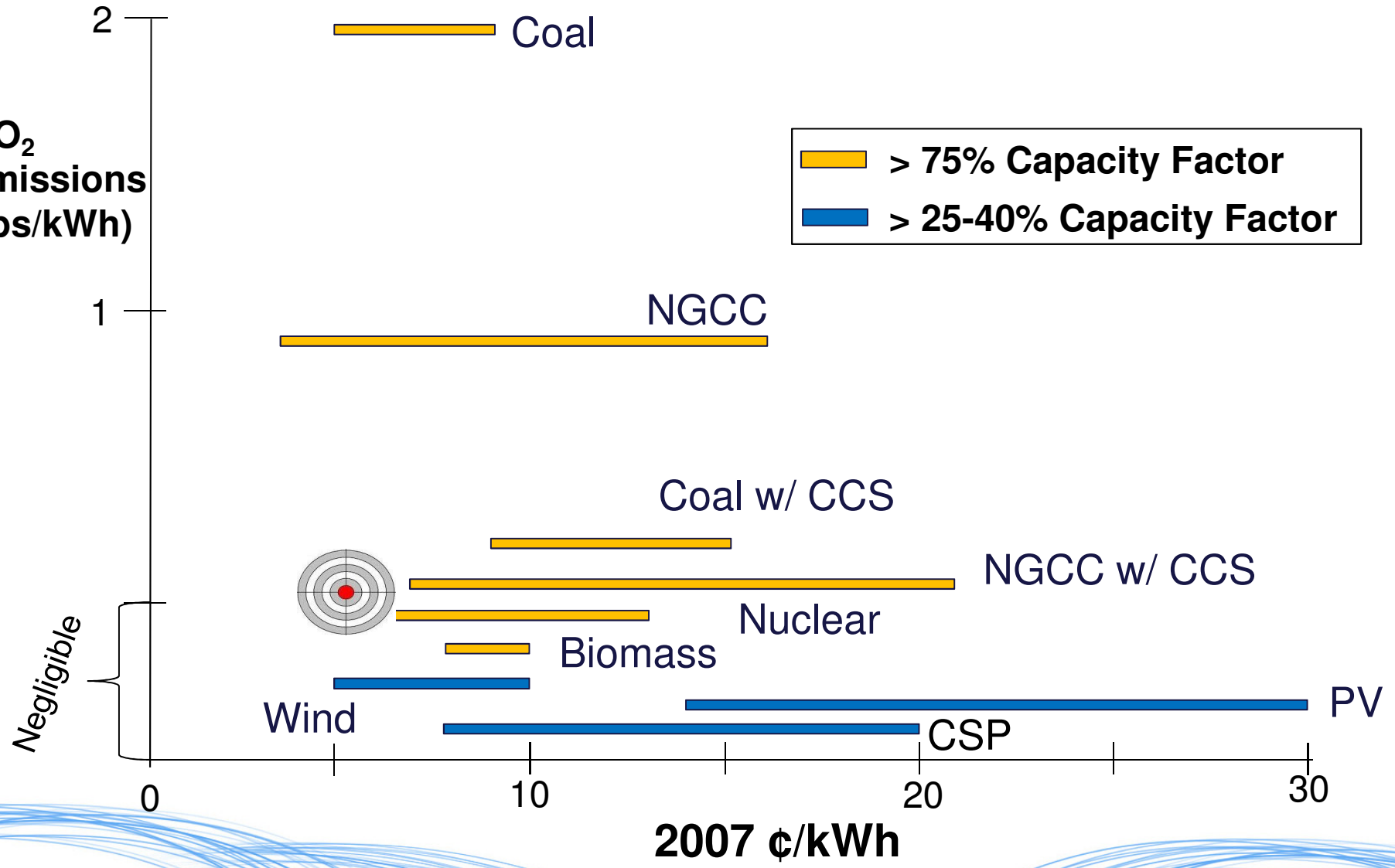
Worldwide electricity projections

World electricity generation (trillion kilowatt-hours)



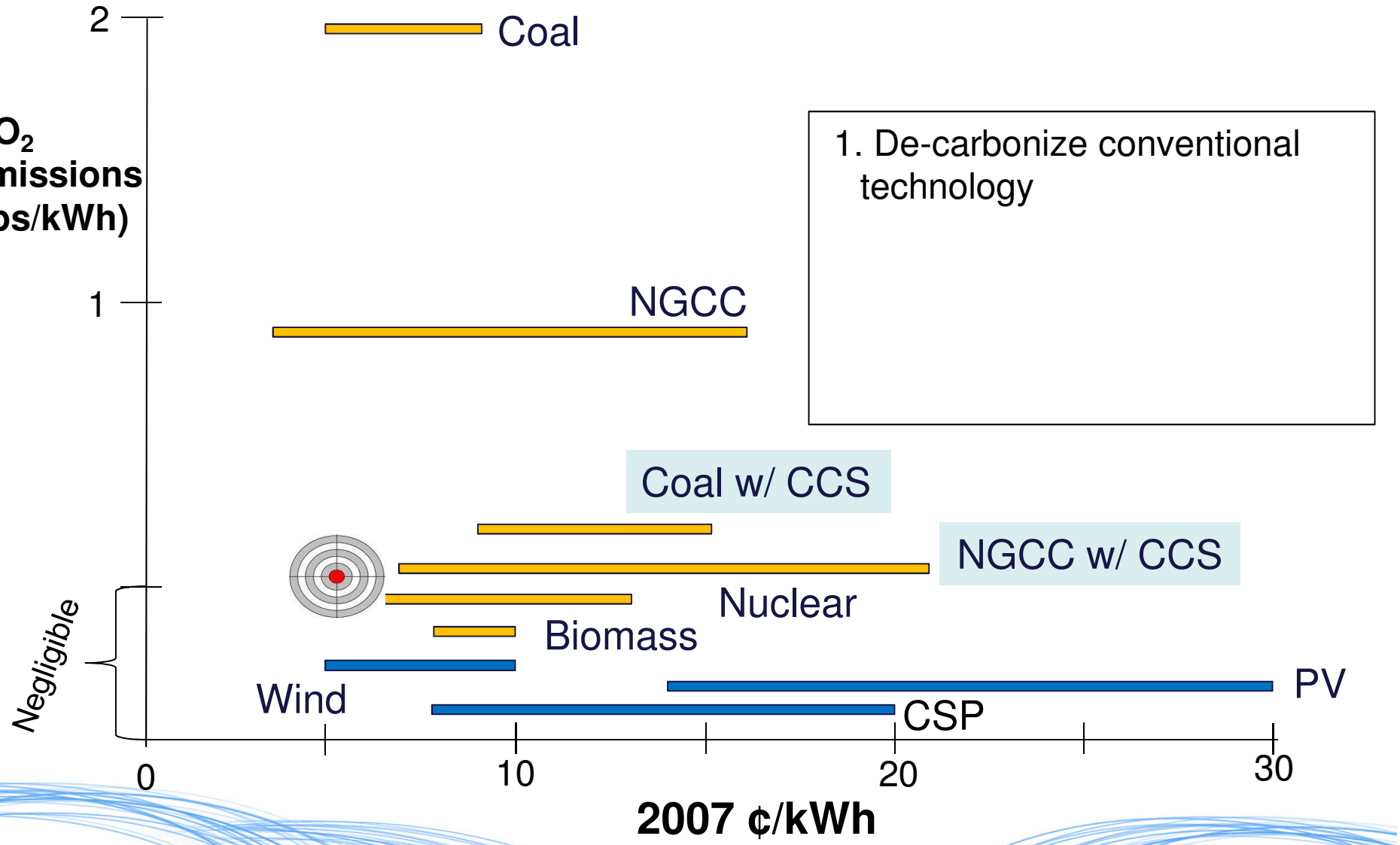
Source: EIA International Energy Outlook (2011)

ARPA-E's goal: carbon-neutral at low cost



Source: "America's Energy Future," National Academies (2009)

ARPA-E's goal: carbon-neutral at low cost



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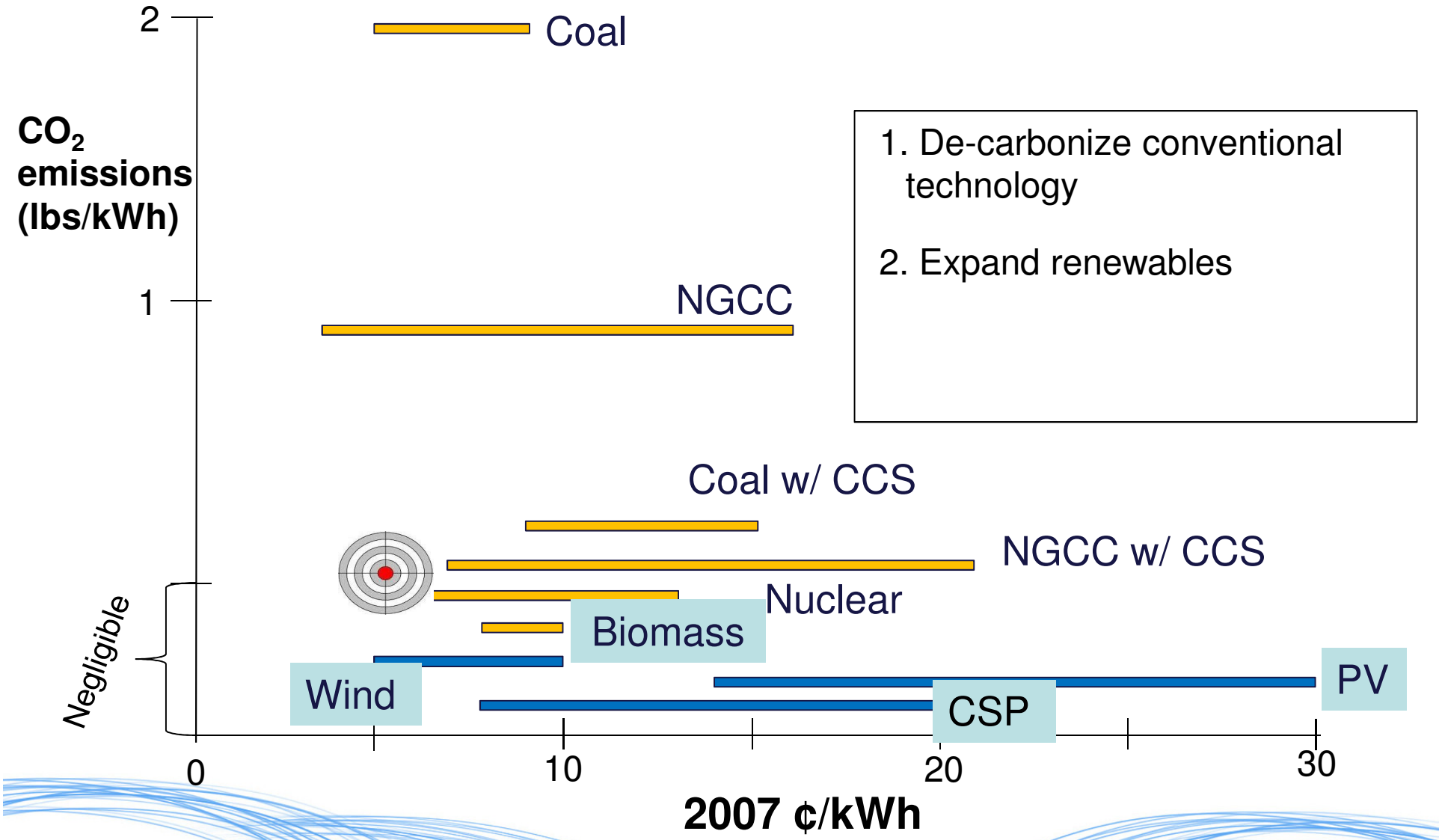
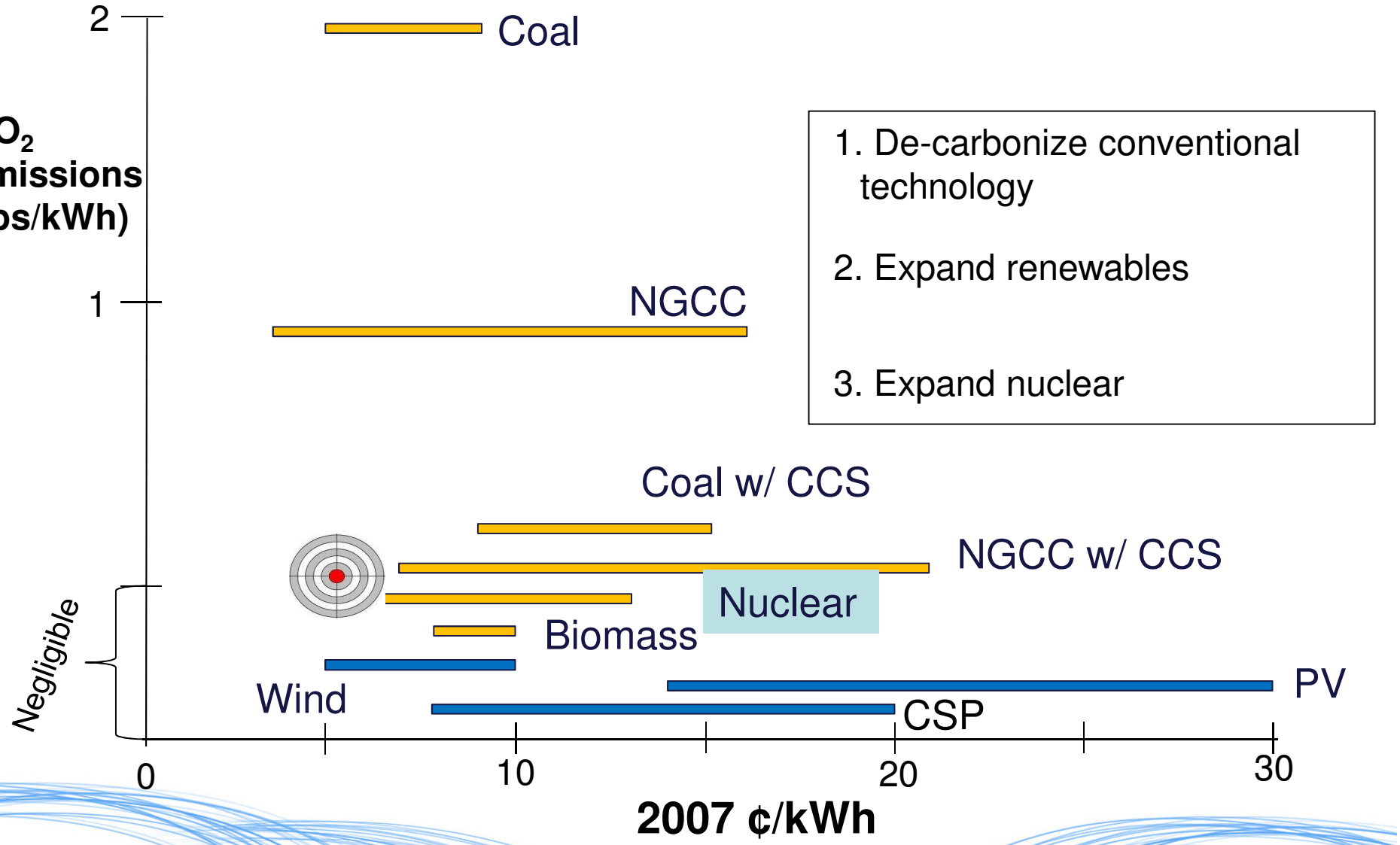
ARPA-E's goal: carbon-neutral at low cost



1. De-carbonize conventional technology
2. Expand renewables

Source: "America's Energy Future," National Academies (2009)

ARPA-E's goal: carbon-neutral at low cost



1. De-carbonize conventional technology
2. Expand renewables
3. Expand nuclear

Source: "America's Energy Future," National Academies (2009)

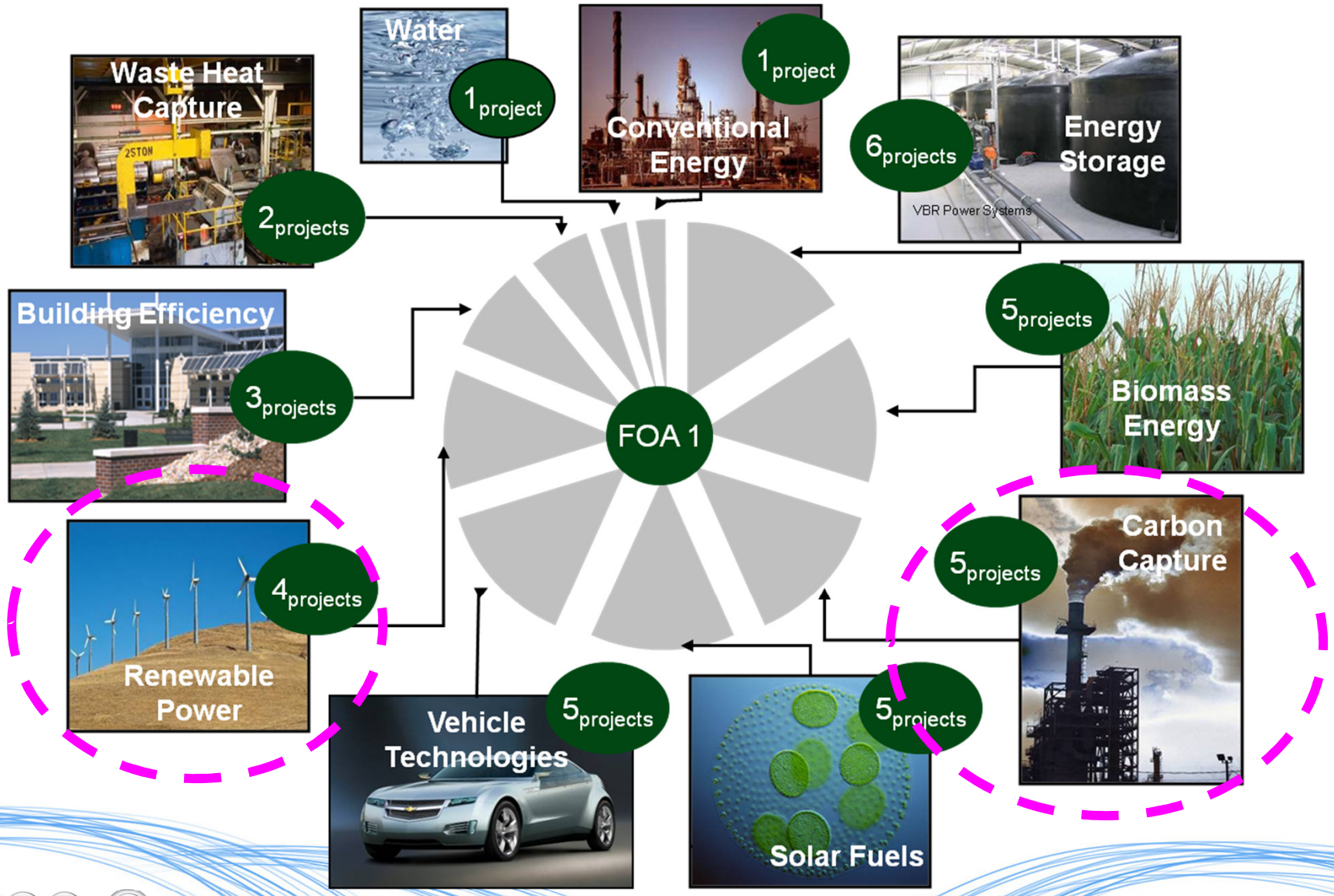
ARPA-E has not funded nuclear projects

Typical ARPA-E Project: $3-4 M per project

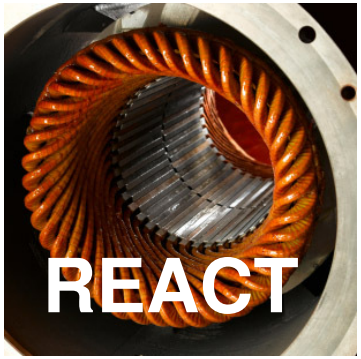
HEATS Program

Can nuclear be used for peaking power?

First Funding Opportunity Announcement (FOA-1)



ARPA-E Programs in Zero Carbon Power



Rare Earth Alternatives in Critical Technologies

Solar Agile Delivery of Electrical Power Technology

High Energy Advanced Thermal Storage

Innovative Materials & Processes for Advanced Carbon Capture Technology

What makes an ARPA-E project?

1. Impact

- High impact on ARPA-E mission areas
- Credible path to market
- Large commercial application

2. Transform

- Challenges what is possible
- Disrupts existing learning curves
- Leaps beyond today's technologies

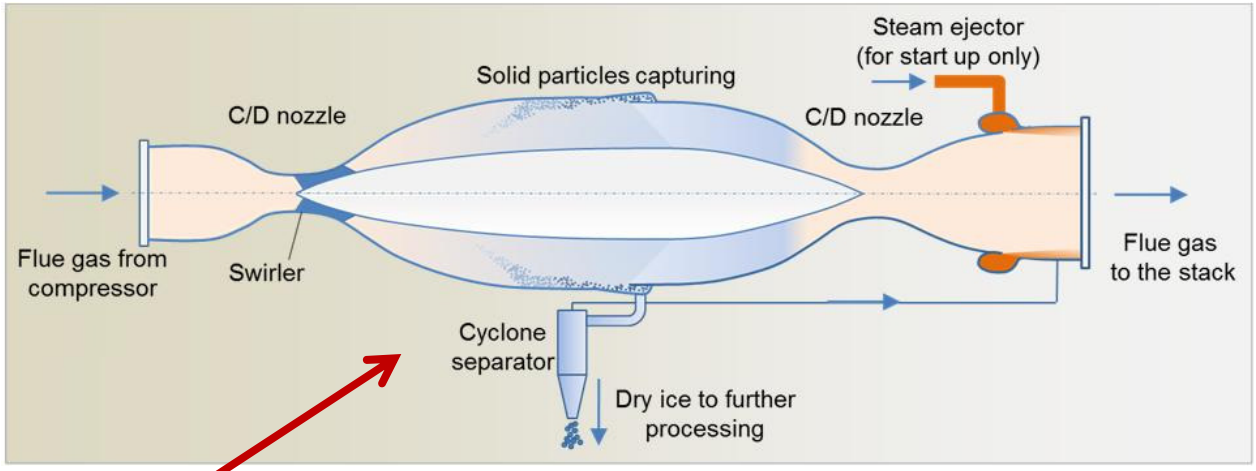
3. Bridge

- Between basic science and applied technology
- Not researched or funded elsewhere
- Catalyzes new interest and investment

4. Team

- Best-in-class people
- Cross-disciplinary skill sets
- Translation oriented

Supersonic duct for solid CO_2 separation



ATK

ACEnT laboratories

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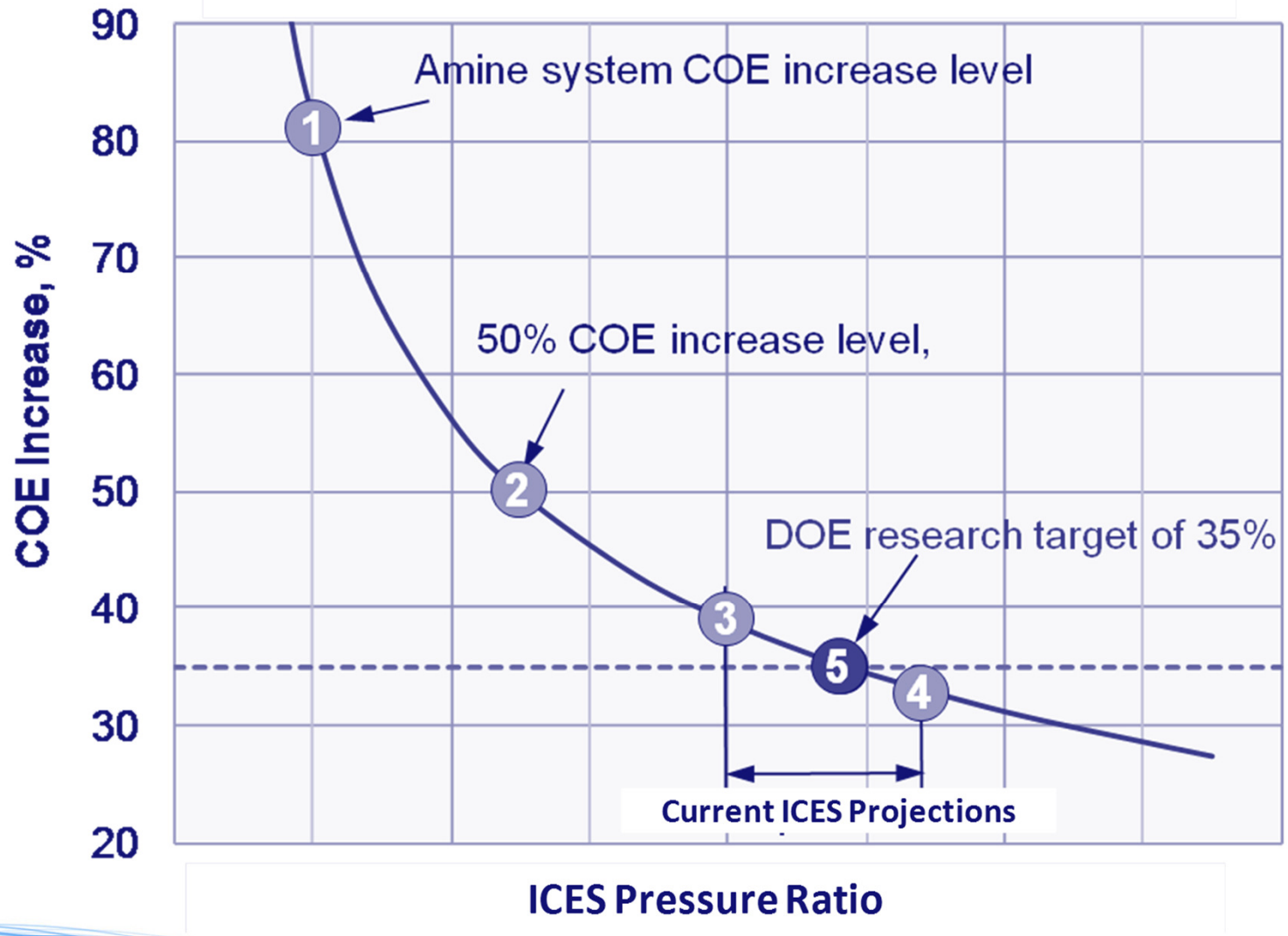
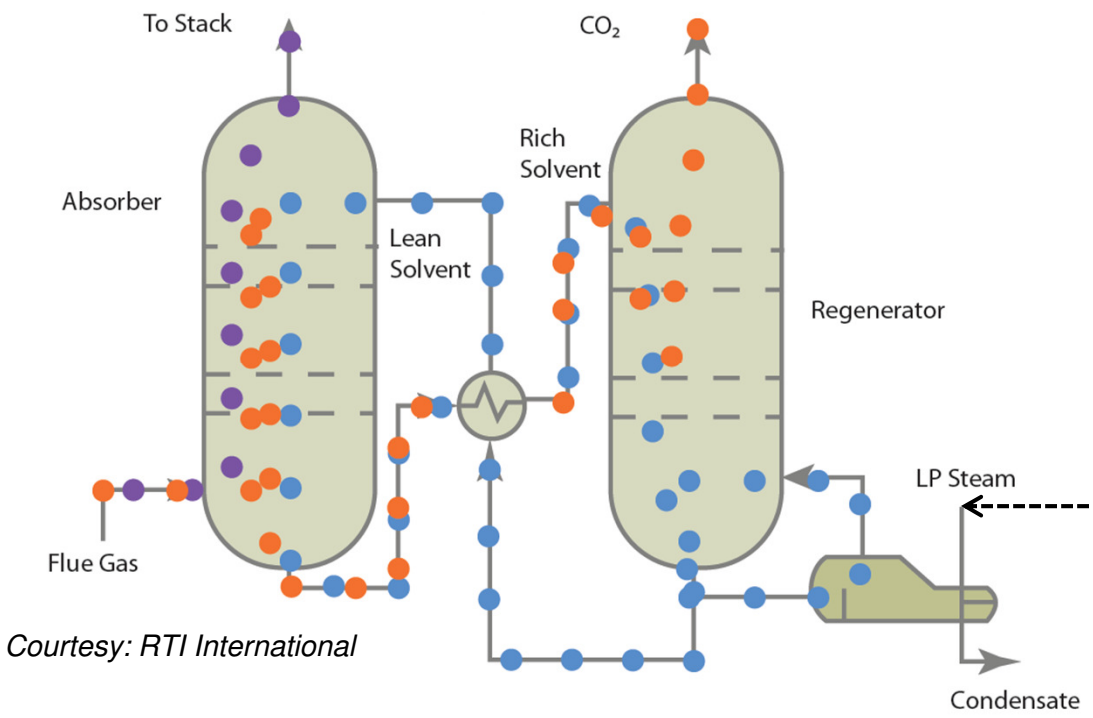
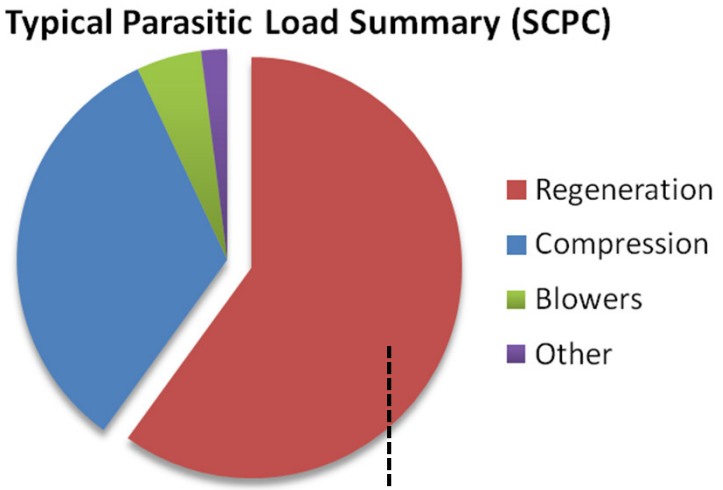
Economics of supersonic capture



CO_2 capture process that exploits waste heat



Courtesy: RTI International

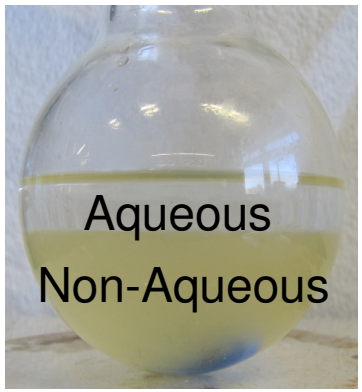


- Quality steam is diverted toward solvent regeneration.
- Much of the steam is used to heat water.

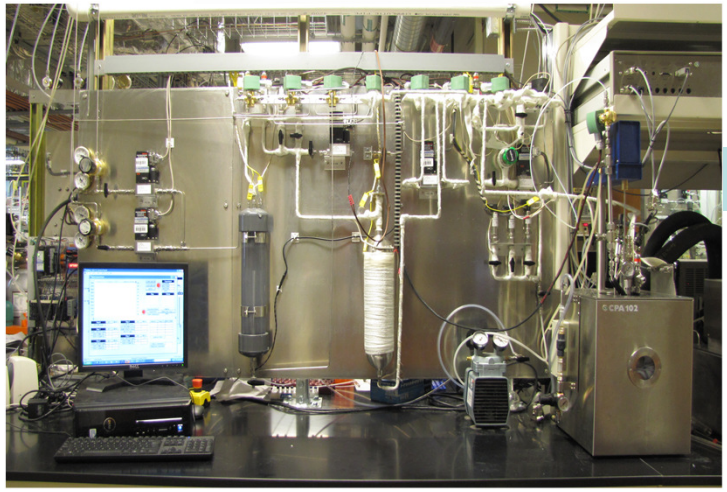
CO_2 capture process that exploits waste heat

RTI approach

- Low temperature regeneration
- Non-aqueous solvent



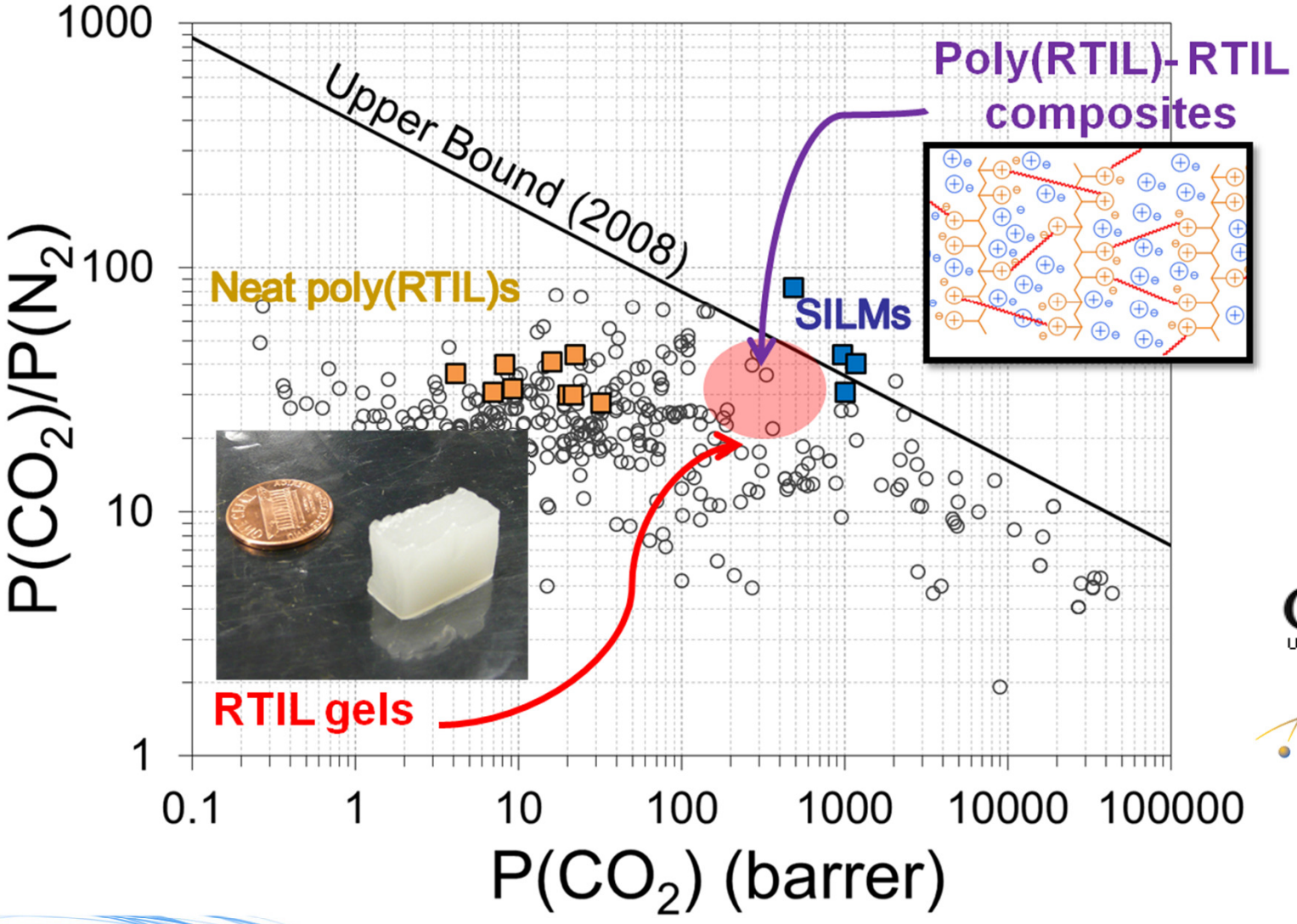
RTI INTERNATIONAL



BASF
The Chemical Company

Potential Impact: 40 percent less energy used than conventional amine-based solvent processes

A 10,000 GPU selective membrane for CO_2



Colorado
University of Colorado at Boulder

Los Alamos
NATIONAL LABORATORY
EST. 1943

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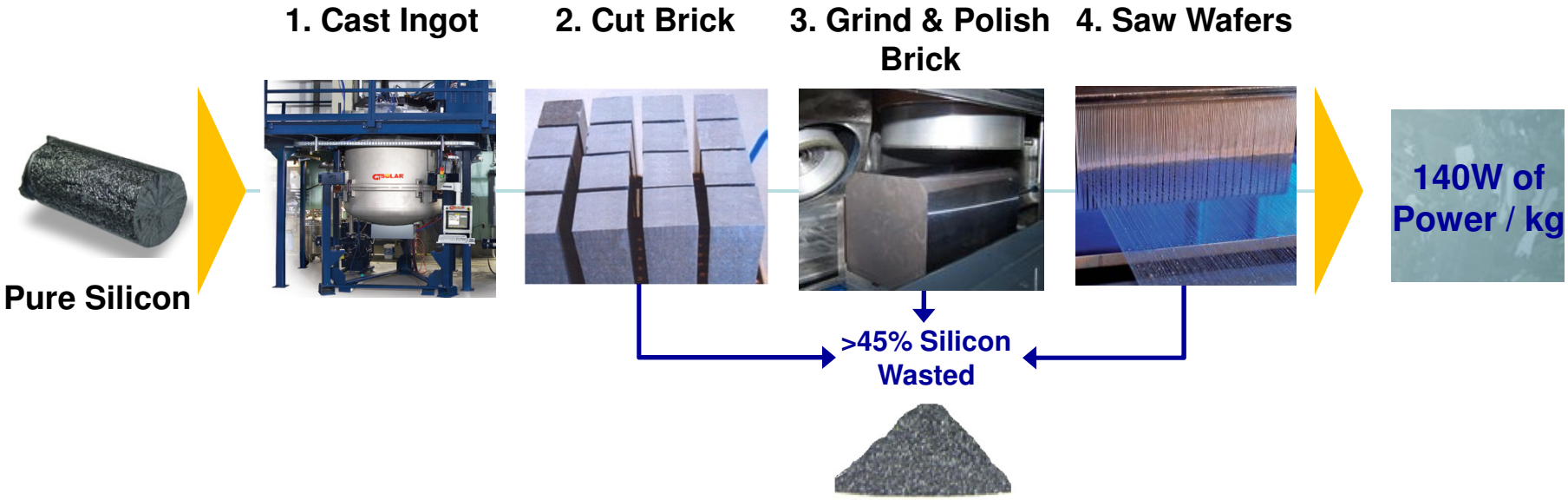
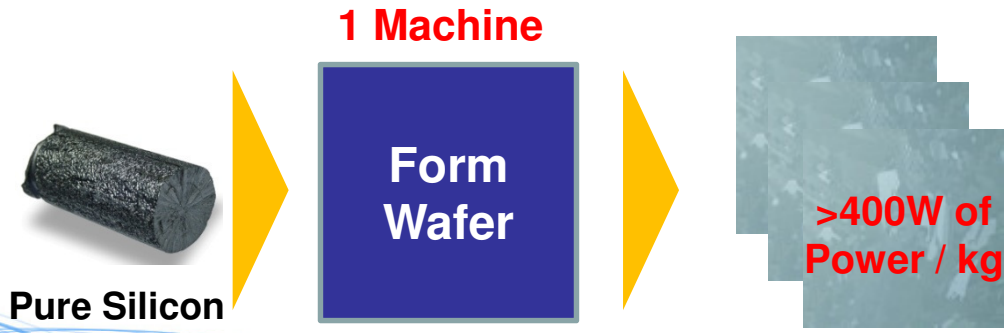
1366 Silicon Wafers: Solar at the cost of Coal

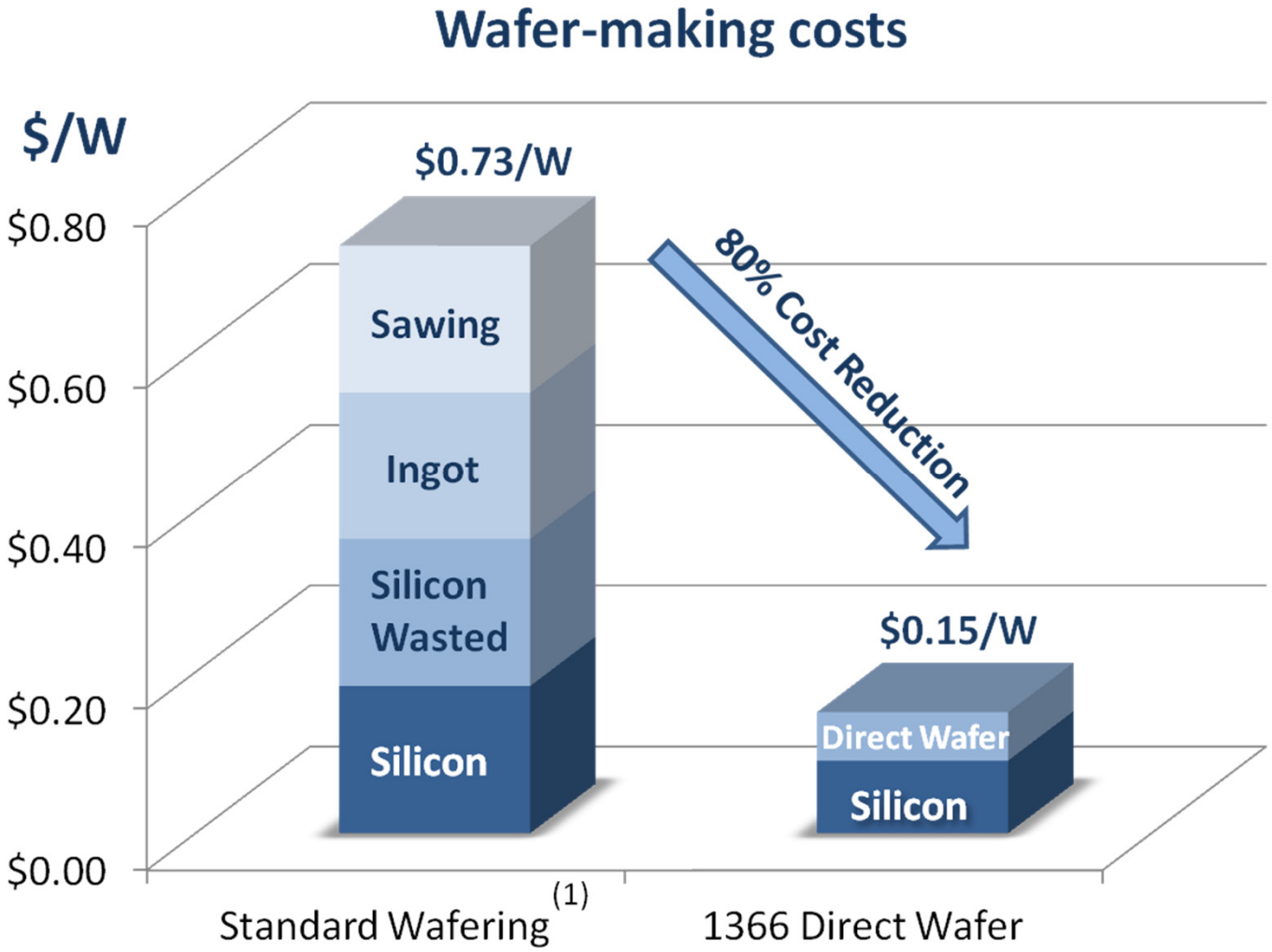
Old Process



1366 Direct Wafer



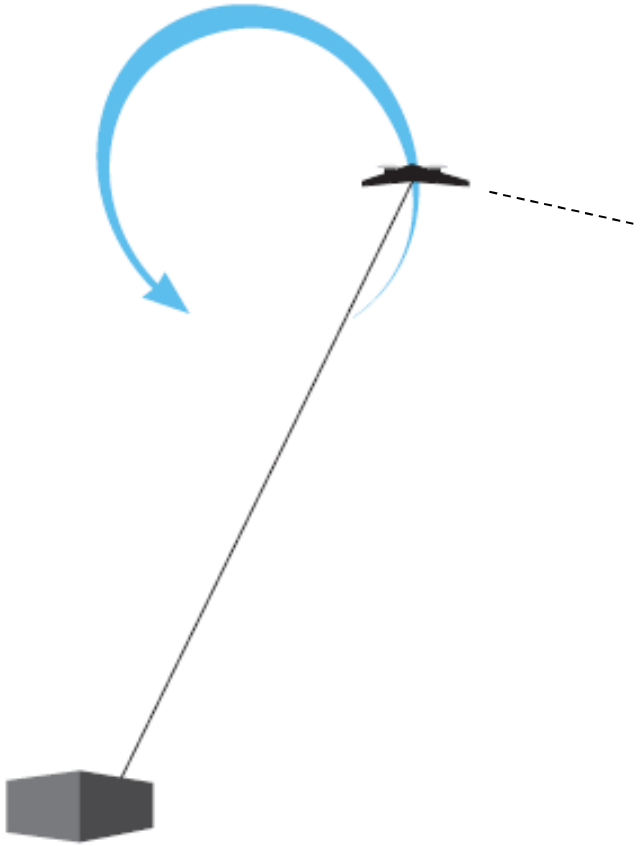
1366 Wafers: A major supply chain disruption



(1) Standard costs from Photon December 2008, Centrotherm estimates. *Assumes silicon cost of $50/kg.

Airborne Wind Turbine

MAKANI POWER
HIGH CAPACITY WIND



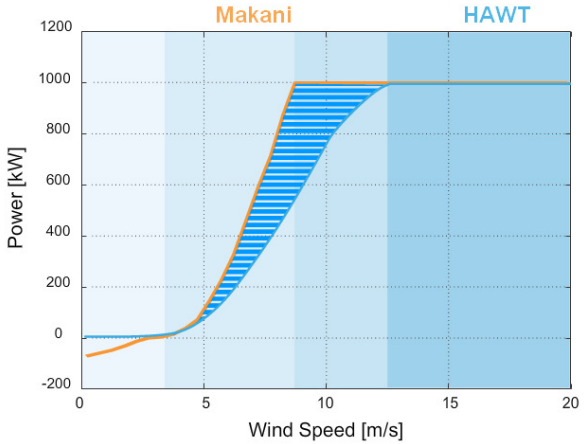
onboard generation

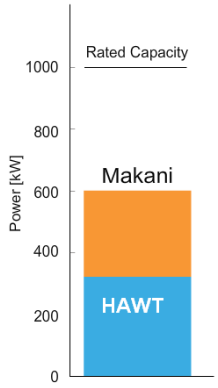
hover

arpa·e

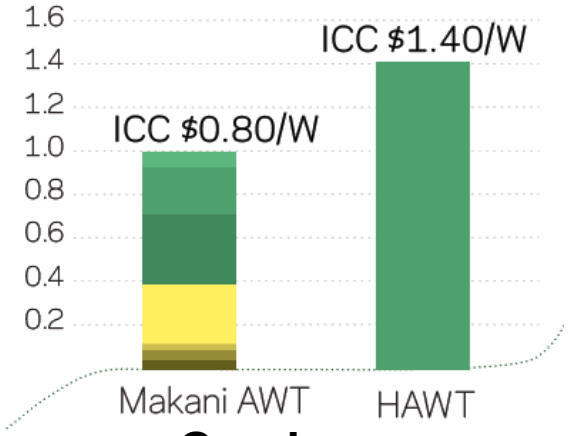
Why Airborne Wind Turbines?

Performance Advantage

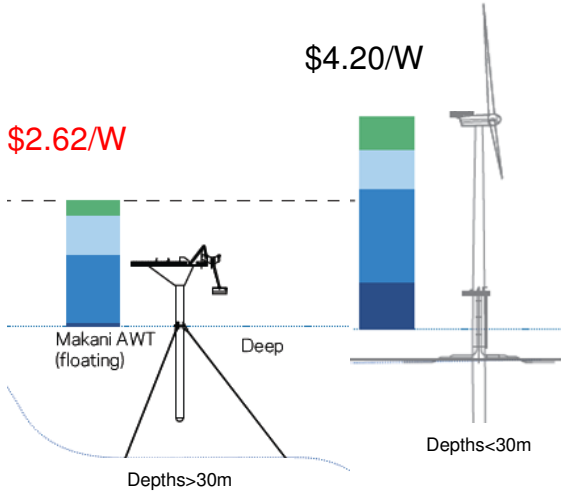




Capital Cost Advantage



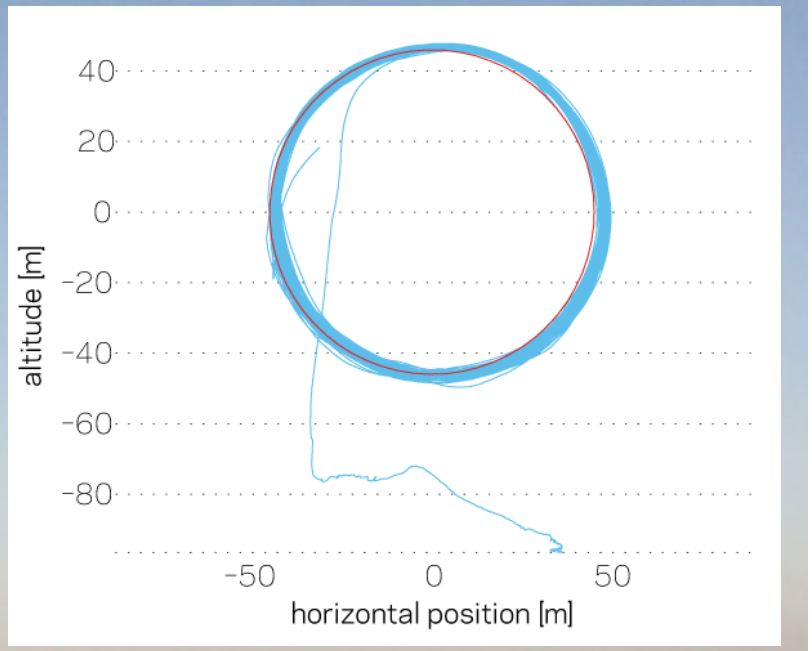
On-shore



Off-shore

MAKANI POWER

HIGH CAPACITY WIND



Q&A

- ARPA-E intends to release an Open FOA on or about March 2, 2012
- We cannot discuss the following:
  - Whether ARPA-E would consider your idea "transformational"
  - Proposal strategies
  - Suggestions for specific content